Switching on Cow Power

Photos courtesy University of Vermont Extension Service

Co-ops can play role in turning dairy waste into energy and byproducts

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Editor's note: This article is based on Research Report 217, "Cooperative Approaches for Implementation of Dairy Manure Digesters," published by USDA Rural Development. This is the second of two articles relating to the use of anaerobic digestion of cow manure to produce renewable energy and other benefits. See "Carbon Credits for Farmers," page 10 of the November-December 2008 issue. (Back issues are online at: www.rurdev.usda.gov/rbs /pub/openmag.htm, or e-mail: dan.campbell@wdc.usda.gov to request a hard copy.)

Dairy operations across the nation routinely handle about 500 billion pounds of cow manure each year by collecting, storing and spreading it over the land. In large manure-storage structures, such as lagoons, little oxygen can dissolve into the mix, creating anaerobic (in the absence of oxygen) conditions. Certain microbes found naturally in manure feed on undigested materials in the manure and, as part of the digestion process, give off gas that contains 60 to 70 percent methane.

In recent years, several factors have converged to spark fresh interest among dairy farmers and others in anaerobic digestion systems. Economies of size in milk production have lead to an increase in the number of cows on the average dairy operation. This increased concentration of

cows has raised concern over environmental issues surrounding manure management.

At the same time, sharp increases in energy costs, along with concern over energy supplies, have spurred interest in renewable sources of energy. The current desire to reduce levels of carbon dioxide, methane and other so-called greenhouse gasses (gasses thought to cause an increase in the Earth's temperature) have also led federal, state and local governments to encourage farmer use of anaerobic technology.

Anaerobic digestion of manure

An anaerobic digester system provides a favorable environment (absence of oxygen, optimal temperature) for methane-producing bacteria to thrive and a means of capturing and collecting the biogas produced by the microbes as they digest (or decompose) the manure.

The biogas captured from the digester can be used for fuel in any equipment that normally uses propane or natural gas. These include boilers, heaters, chillers, internal combustion engines or gas turbines used for generating electricity. In addition, heat energy produced by these stationary engines running on biogas can also be captured and put to useful purposes. In some applications, it may be beneficial to the equipment to remove the hydrogen sulfide present in biogas (i.e., "clean" the gas) prior to use.

Alternatively, the biogas may be cleaned and conditioned (water and carbon dioxide removed and gas compressed) for sale to a commercial gas pipeline. Cleaned and compressed gas can be used in mobile engines configured to run on natural gas or similar fuel.

Furthermore, the methane in biogas captured from anaerobic digestion of dairy cow manure may be qualified to receive carbon credit if it is flared (burned off) or otherwise prevented from emitting into the atmosphere. The global warming potential of methane is equivalent to at least 21 times that of carbon dioxide. This means that preventing one unit of methane gas emission has the effect of reducing the amount of greenhouse gas emission equivalent to a reduction of 21 units of carbon dioxide.

The manure effluent leaving a digester, while not significantly reduced in volume, is biologically stabilized (meaning it is fully decomposed and the compounds contributing to manure's unpleasant odors are eliminated).The solids in the manure effluent can be separated, perhaps composted, and used in applications such as bedding for cattle, a soil amendment, or as a gardening product, such as potting soil. The remaining liquid effluent can be used to fertilize fields and crops, or even further fractionated into manure concentrate and "treated" water for discharge.

Economic impact on dairy farming

The net economic impact of installing an anaerobic digester on a dairy operation depends on the dairy's ability to use the biogas, digested solids and liquid effluent.

Utilization of the end products of manure digestion can lower the dairy operation's operating costs, add income from sales or provide a combination of avoided expenses and increased revenue. Some notable benefits of anaerobic digestion, such as the reduction of offensive odors and improved ease of manure management, are not easily quantifiable in terms of dollars and cents.

At the same time, capturing the benefits of anaerobic digestion will require additional expenses, such as purchase, operation and maintenance of equipment to use the biogas and to prepare the byproducts for use or sale, as well as increased management time and skill. The benefits and costs associated with anaerobic digestion of dairy cow manure that have been observed or predicted are identified in the table on page 20.

Whether the cost of an anaerobic digester is sufficiently offset by its benefits — both tangible and intangible — depends upon each dairy's situation.

Obstacles

Lessons learned from previous efforts in producing biogas from manure resulted in improved design, operation, equipment and cost-effectiveness of anaerobic digestion systems. However, only 95 anaerobic digester projects that use dairy manure were identified by the U.S. Environmental Protection Agency in 2007.

While anaerobic digesters may not be appropriate for every dairy farm, these 95 projects represent a very small fraction of the nation's 59,000 licensed dairy herds.

The set of barriers to adoption are often unique to each producer's situation. The challenges reported by dairy producers using (or attempting to use) anaerobic digesters in their operations have included:

- Low rates paid by utilities for electricity generated by biogas-fueled generators;
- Difficulties connecting to the power grid;
- Difficulties adapting the anaerobic digester to a farm's existing manure system;
- Limited number of anaerobic digester system providers;
- Lack of information about anaerobic digesters;
- Added demand on a dairy farmer's time and new skills needed to manage the digester;
- Lack of ability to capture value from use or sale of byproducts;
- Difficulties in obtaining financing and/or funding for high digester capital costs.

A role for cooperatives?

A cooperative approach may be one way for dairy farmers to overcome obstacles to the successful use of anaerobic digesters. Dairy producers could take one of two basic approaches: 1) an existing dairy cooperative could provide services related to the adoption of anaerobic digester technology as a part of its member services, or 2) a group of

Possible benefits and associated costs from byproducts of anaerobic digestion of dairy manure

By Product	Benefits	Costs
Electricity	■ Avoided electricity purchases ■ Electricity sales	■ Electricity production equipment ■ Operating and maintenance ■ Required upgrades to electrical system ■ Sales negotiation, legal fees
Biomethane	■ Natural gas sales	■ Biogas collection ■ Gas cleaning ■ Storage/ transportation
Heat	■ Heat/hot water	■ Equipment, operating and maintenance
Digested solids	■ Avoided bedding purchases ■ Sales of separated solids	■ Equipment, operating and maintenance ■ Sales negotiation and/or marketing
Carbon Credits	■ Sales	■ Aggregation fee ■ Trading fee ■ Verification costs
Fertilizer	■ Lower energy use in handling effluent ■ Avoided purchases ■ Flexibility in timing for land application ■ Improved nutrient quality ■ Lower herbicide use ■ Sales	■ Sales negotiation and/or marketing
Environment	■ Reduced odor ■ Reduced water contamination risk ■ Avoided lawsuits ■ Pathogen reduction ■ Methane destruction/capture ■ Tipping fees — fees that firms may pay to dispose of their organic waste in a farmer's digester, which also may boost the digester biogas output.	■ Substrate (organic wastes) management and negotiation

similarly situated dairy farmers could form a separate entity to address their specific needs.

The group effort may be more effective and efficient than each farmer facing the challenges of adopting anaerobic digester technology alone. Collective effort may enhance the economic feasibility of anaerobic digesters by lowering the installation and operating costs, increasing returns from energy and byproduct sales — or both — while allowing milk producers to remain focused on milk production.

Cooperation could be effective in several areas, such as:

Negotiation — A cooperative may engage (either by employment or by contract) experts to negotiate rates and terms of trade with utilities, digester suppliers, firms that wish to dispose their organic waste into the digester, and so forth. A group of dairy producers would have more market power to command favorable terms, or gain higher quality expertise at lower cost to address their specific needs, than they would if acting as individuals.

Services — A cooperative could hire or contract with technical experts to provide information, leads, analysis and expertise. This would allow members to avoid the full cost of finding and vetting such expertise. Services might include:

- Technical assistance in setting up and operating a digester and trouble-shooting problems so a producer does not have to "reinvent the wheel" to implement the technology.
- Digester management services, where a cooperative manages the members' anaerobic digesters and biogas utilization operations, leaving the farm operators free to focus on milk production.
- Back-up equipment: cooperatively owned biogas-utilization equipment that can be maintained and made available to members when their equipment is down for repairs or maintenance.
- Manure hauling service: if there is a centralized digester, a cooperative could provide manure and effluent shipping coordination and services (including attention to biosecurity issues related to manure transfer), relieving the members of the management burden. Members could share the cost of equipment for shipping manure to the central location.
- Financing information and/or grant management: a cooperative could provide grant management for its members, or, at minimum, provide information to both producers and bankers. A large existing cooperative may even be able to provide loans with favorable terms to producers wishing to install a digester.

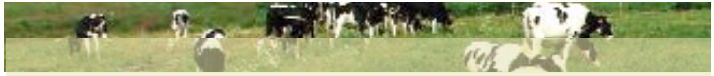
Marketing — A cooperative could assist members in marketing products derived from anaerobic digestion (biogas-fueled electricity, digested solids, liquid effluent fertilizer, natural gas and carbon credits). A cooperative could also research potential uses for digested solids and liquid effluent, develop standardized marketing materials and product guidelines, or assist utilities in developing and marketing "green energy" resulting from anaerobic digestion.

A group marketing effort would represent a larger volume than an individual dairy, which may increase marketing efficiencies and effectiveness, or even open up new marketing channels. Possibly, a cooperative could operate a common by-product packaging and distribution venture for members located in close proximity.

Centralized Systems: Under certain circumstances, a group of closely located small- and medium-size dairy producers may be able to more effectively operate a common digester fed by member-farms' manure than if each member installs a digester on their own operation. The advantages of a centralized digester are that risk, capital costs, digester operating and maintenance responsibilities, as well as byproduct marketing, would be borne by the cooperative. However, transporting manure to a central location introduces the potential for pathogens to be transferred between farms.

Alternatively, producers in close proximity to a natural gas pipeline may be able to truck or pipe the biogas generated on their operations to a central gas clean-up and conditioning plant located at the pipeline insertion point. They could cooperatively own and operate the gas cleanup plant and perhaps even the transportation infrastructure for getting the biogas to the plant.

The cooperative effort could be narrowly focused on one obstacle or one opportunity, or incorporate multiple functions. Alternatively, a cooperative could focus on one effort initially and gradually take on more functions as it builds on its successes.



Possible benefits of a cooperative effort to support the adoption of anaerobic digesters by dairy producers

Energy	■ Improved compensation for electricity produced ■ Favorable terms for connecting to the electrical grid ■ Natural gas marketing
Byproducts	■ Technical guidance on utilizing digested solids and effluent on farm ■ Marketing research & development for byproduct sales
System design	■ Technical guidance for design/installation ■ Negotiated prices for digester components/installation ■ Provider screening
Management	■ Technical guidance to boost biogas production ■ Management assistance to reduce operating costs
Carbon Credits	■ Aggregation and trading ■ Reduced fees

Funding a cooperative

One way that a cooperative effort could be funded would be to charge a per-cow fee based on the number of milk cows on each member's operation. Alternatively, a cooperative could mark up prices and fees for its products and services to cover its cost of providing them. The farmers using the service or benefit should be the ones funding its availability.

As with the anaerobic digester technology itself, dairy producers will have to evaluate whether the benefits of acting together to address their needs in using a digester outweigh the costs.

The value of a cooperative effort depends upon its effectiveness in enabling members to increase net returns to anaerobic digestion. The sidebar (above) identifies five key areas where a cooperative effort may assist producers in capturing benefits from anaerobic digestion at lower cost. ■